

## METHOD AND APPARATUS TO MAINTAIN WIRELESS NETWORK

## COMMUNICATIONS THROUGH A FIREWALL

## CROSS REFERENCES TO RELATED APPLICATIONS

Not Applicable

## STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR

## DEVELOPMENT

Not Applicable

## REFERENCE TO A "MICROFICHE APPENDIX"

Not Applicable

## BACKGROUND OF THE INVENTION

### FIELD OF THE INVENTION

**[0001]** The present invention relates to a method and apparatus to maintain open communication pathways between a mobile device and an asset server. More particular, the invention relates to preventing a firewall from closing communication pathways in an asset tracking system.

### DESCRIPTION OF THE RELATED ART

**[0002]** The prior art relates to systems that use wireless networks. In such a system, a person on a cellular phone device communicates with a message recipient. The message recipient could be another person on a landline or cellular phone. Person to person calls are the most common use of cellular systems.

**[0003]** However, wireless systems have started providing other services as cellular technology has advanced. Cellular service providers have started to migrate to newer CDMA and GSM cellular systems. These newer cellular systems allow data transmissions. Data from a sender to

a recipient can travel over the cellular network. Thus, text messaging, email, and internet connectivity are all possible. These newer cellular systems operate as packet-switched networks. Packet-switched networks allow a cellular user to send and receive data via internet protocol transmissions. Unfortunately, these advancements in technology have created some problems.

**[0004]** First, the cellular service providers have erected firewalls in the wireless systems.

Cellular service providers have erected these firewalls to prevent a deluge of unwanted messages overwhelming the cellular network. A firewall prevents unwanted transmissions from being sent to a cellular user. Typical examples of unwanted messages would include spam email or pop-up windows. To prevent these unwanted transmissions, the firewall blocks any transmissions from systems outside the wireless system. In essence, a cellular user can send data to any system. However, only solicited transmissions reach the cellular devices.

**[0005]** Second, the packet-switched networks also use dynamic IP addressing. Every device in an IP network has an address. This IP address is a set of bits that identify that device in the system. IP addresses function like mail addresses. When a system has information to send to the device, the system uses the IP address. The network routes the information through the system until it reaches the device with the IP address. In newer technology, dynamic IP addressing changes the paradigm. Now, a device does not keep the same IP address all the time. Instead, when a user sends information with the device, the network attaches an IP address to the communication. A responder to the communication can extract that IP address and use it to respond to the information.

**[0006]** Both of these changes have had impacts on systems using wireless networks. In particular, asset tracking systems have been affected by the advances in technology. An asset tracking system is a system that uses mobile devices and attached position finders to monitor the

location of the asset. These systems have many applications. In particular, public services, like the police, fire, emergency management systems (EMS), or public works agencies, use these systems to more effectively and efficiently serve the public. Private companies have also adopted asset tracking systems to monitor sales persons, service vehicles, and inventory.

[0007] In an asset tracking system, the position finder, usually a GPS device, provides data about the location of the asset to the mobile device. The mobile device sends this information to an asset server. The asset server provides the data to a customer's system. Common customers are GIS systems that graphically display the location of the asset.

[0008] The problems the new wireless systems created involve situations when an asset server wants to push data to the mobile device. In many asset tracking systems, the asset servers provide data to the mobile devices. This data may include an address to which a police car or fire engine should respond. Data may also include text messages or driving directions.

Unfortunately, asset tracking systems cannot push data in a packet switched network. First, any data sent to the mobile device is blocked by the firewall. A wireless network sees this data as unwanted information and prevents its transmission to the mobile device. Second, the asset server cannot know the mobile devices IP address from one time to the next time. Since the wireless network uses dynamic IP addressing, the asset server could send a message with an IP address once and then, after a period of time, that IP address changes. Thus, subsequent messages fail to get to the mobile device.

[0009] Some asset tracking systems have addressed these problems by constructing private networks. In essence, the agency using the asset tracking system builds, buys, or leases all or a part of a wireless network. This type of wireless network is normally called a private network and is dedicated to the asset tracking system. These private networks do not allow transmissions

from outside public systems onto the private network. To accomplish this segregation, the private network normally has dedicated transmission lines, IP routers, and other physical hardware. Due to their closed nature, private networks do not need firewalls or dynamic IP addressing. With the threat of unwanted messages eliminated, firewalls are never erected and do not prevent communications in the private network. The private network allows static IP addressing because there are a limited number of devices on the private network. Unfortunately, building, buying, or leasing a private network can be very expensive. Most companies and public agencies do not have the budget to acquire the use of a private network. Thus, these companies and agencies are forced to use the public wireless network and must find another solution to the problems created by the newer packet-switched wireless networks.

[0010] Methods and apparatuses are needed to allow asset servers to push data to mobile devices on packet-switched wireless networks.

#### BRIEF SUMMARY OF THE INVENTION

[0011] The present invention relates to a method and apparatus to maintain a data connection over a private or public, packet-switched, wireless network. An asset tracking system sends heartbeat signals between a mobile device and an asset server. The heartbeats perform several functions. First, the heartbeats inform the asset server that the mobile device is active and on the network and vice versa. Second, a heartbeat from the mobile device provides the dynamic IP address to the asset server for successive communications. Third, a first heartbeat from a mobile device opens a hole in the firewall of the wireless network. Finally, successive communications maintain the hole in the firewall.

#### BREIF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0012] **FIG. 1** shows an embodiment of an asset tracking system using heartbeats to open and maintain communication channels in accordance with the present invention.

[0013] **FIG. 2** shows one embodiment of a mobile device that can use heartbeats to open and maintain communications channels in accordance with the present invention.

[0014] **FIG. 3** shows one embodiment of an asset server that can use heartbeats to open and maintain communications channels in accordance with the present invention.

[0015] **FIG. 4** shows a method of using a heartbeat to maintain a communication channel in accordance with the present invention.

[0016] **FIG. 5** shows an embodiment of a heartbeat in accordance with the present invention.

[0017] To clarify, each drawing includes reference numerals. These reference numerals follow a common nomenclature. The reference numeral will have three digits. The first digit represents the drawing number where the reference numeral was first used. For example, a reference numeral used first in drawing one will have a number like 1XX while a number first used in drawing five will have a number like 5XX. The second two numbers represent a specific item within a drawing. One item in drawing 1 will be 101 while another item will be 102. Like reference numerals used in later drawing represent the same item. For example, reference numeral 102 in **FIG. 3** is the same item as shown in **FIG. 1**.

#### DETAILED DESCRIPTION OF THE INVENTION

[0018] The present invention will be described in reference to an asset tracking system 100. However, the invention is not meant to be limited to that one embodiment. For example, the present invention may be used to facilitate the transfer of text messages between a mobile computer and some message recipient. There are other systems that may require continuously

open communications in a wireless or other packet-switched network. Therefore, this invention applies to those other systems.

#### Asset Tracking System

[0019] **FIG. 1** shows one embodiment of an asset tracking system **100**. This embodiment may include, but is not limited to, several assets **102**, one or more wireless or packet switched networks **104**, one or more internet connections **114**, an asset server **116**, and one or more customers **122**.

[0020] The assets **102** in the asset tracking system **100** may include several different things. Some items that may be considered assets **102** include, but are not limited to, people, vehicles, shipping containers, aircraft (airplanes, helicopters, etc.), watercraft (boats, jet skis, etc.), train cars, or goods inventory. Practically anything an organization wants to track can be an asset **102** in an asset tracking system **100**. One skilled in the art will recognize other items that may be considered assets **102**.

[0021] In one embodiment, the assets **102** may be people. For example, the asset tracking system **100** may track the deployment of firefighters to a forest fire. Since vehicles are not able to navigate many wooded areas, people must often respond to forest fires. Thus, the asset tracking system **100** may track these people. Other organizations may track people as assets **102** including the military tracking soldiers, companies tracking salesman, or mining companies tracking miners. One skilled in the art will recognize other situations where an organization may track people as an asset **102**.

[0022] In the embodiment shown, the assets **102** are vehicles. In this embodiment, the asset tracking system **100** may be an automatic vehicle location (AVL) system. An example of an asset tracking system **100** where the assets **102** are vehicles is the typical system used by city fire

or police agencies. In these systems, the assets **102** are the fire trucks or police cars. These vehicles are tracked and directed throughout the city to respond to public safety emergencies. Although **FIG. 1** shows the assets **102** as vehicles, the present invention is not limited to that embodiment, but the invention includes all items or things that may be tracked as assets.

**[0023]** To communicate between the asset **102** and the asset server **116**, the asset tracking system **100** may employ one or more communication networks, including but limited to, wireless or packet-switched networks **104** (hereinafter referred to as networks, wireless networks **104**, or packet-switched networks). The embodiment shown uses antennas to depict the networks **104**. While a wireless network **104** is one network **104** that can be used in the asset tracking system **100**, the present invention is not limited to that embodiment. Rather, the asset tracking system **100** can employ any type of communication network or packet-switched network. With regards to the wireless network **104**, the typical wireless network **104** can be a type of cellular network. A cellular network may include, but is not limited to, a PCS, CDMA, TDMA, FDMA, GSM, or other cellular system. Most common of these systems to use a packet-switched network is the GSM and CDMA systems.

**[0024]** In other embodiments, the wireless network **104** may include a system that utilizes an IEEE 802.11 standard. These 802.11 systems can often be found in buildings and can operate as wireless LANs. Other wireless systems like Bluetooth® or other wireless protocol may also be used by the present invention.

**[0025]** Private networks may also be included in the asset tracking system **100**. As explained before, the private network is a non-public system used exclusively by the organization employing the asset tracking system **100**. These private networks can include, but are not limited to, conventional or trunked radio systems, dedicated cellular systems or services, leased

fiber optic systems, or satellite transmission systems. These private networks may include firewalls also. The present invention may be used to maintain communication pathways in these private networks also. Thus, while this description uses public networks as an example, the invention is not limited to that embodiment. Rather, any network, including private networks, that use a firewall is included in this invention.

[0026] In some embodiments, the communications pathway may include an intermediate system 110. An asset 102 may transmit a signal to a wireless or other network which sends the data to an intermediate system 110. That intermediate system 110 can relay the information to the asset server 116. These intermediate systems 110 can include, but are not limited to, other networks, WANs, LANs, or separate computers.

[0027] With any of the networks 104, the asset tracking system 100 may encounter one of the problems mentioned earlier. The first problem may be that one or more of the networks employ dynamic IP addressing. Thus, the network 104 may assign the assets 102 using the network 104 an IP address with each sent message. That IP address may change periodically. Dynamic IP addressing is well known in the art and will not be explained further.

[0028] Second, the network 104 may employ a firewall 126. This firewall 126 can prevent the asset server 116 from pushing data to the assets 102. Any of the networks 104 mentioned above may employ a firewall 126. In some embodiments, only some of the network 104s may employ the firewall 126 while other networks 104 do not. These firewalls 126 may be a software or hardware device. The firewall 126 may be a part of the network 104 or a separate device coupled to the network 104. Firewalls 126 are well known in the art and will not be explained further.



[0029] The asset tracking system 100 may also include an internet connection 114. The internet connection simply means the data is transported over an internet, such as the World Wide Web. As shown in FIG. 1, not all communications may go over the internet 114. Rather, some of the communications pathways may be direct connections from the networks 104 to the asset server 116. For instance, some of the networks 104 may be connected to the asset server 116 by a dedicated T1 line. Other connections are possible. The internet 114 and these direct connections are well known in the art and will not be explained further.

[0030] The asset tracking system 100 will likely include an asset server 116. The asset server 116 can function as the central processor in the asset tracking system 100. This server can collect, route, store, and process the outgoing and incoming data. The asset server 116 is explained in more detail below.

[0031] A final part of the asset tracking system 100 may include one or more customers 122. The customers 122 may include other systems that further process and use the data from the asset tracking system 100. For instance, these customers 122 may be the actually GIS systems at the user's location that use the asset location data. These systems may include any type of GIS or other system capable of providing a user with information about the assets 102. Customers 122 may also provide information into the asset tracking system 100. One skilled in the art will recognize the different systems or processes that may use the asset data.

#### Mobile Device

[0032] Each asset 102 tracked by the asset tracking system 100 includes a type of mobile device 205. FIG. 2 shows a block diagram of an embodiment of the mobile device 205. A mobile device 205 includes at least a wireless transceiver 210 and a position finder 220. Other

components in the mobile device **205** may include, but are not limited to, a processor **215**, a sensor array **240**, a memory **255**, a man/machine interface **250**, and a display device **245**.

[0033] The wireless transceiver **210** includes any device that can send or receive data from a wireless network **104**. Devices may include, but are not limited to, radio transmitters, radio handsets used on conventional or trunked radio networks, satellite transceivers, circuit-switched cellular units, or similar devices. A common wireless transceiver **210** may be a cellular modem. The present invention focuses on assets **102** using cellular devices, such as CDPD modems. These cellular devices may include any type of analog or digital cellular device. The cellular device may be capable of text messaging or other cellular functions. Cellular modems and their equivalents are well known in the art and will not be explained further. While cellular devices are used to describe the invention, the invention is not limited to that one embodiment.

[0034] The mobile device **205** in an asset tracking system **100** should also include a position finder **220**. Without a position finder **220**, the asset tracking system **100** would be unable to determine the position of the asset **102**. Thus, these devices are inherently needed in a mobile device **205** in an asset tracking system **100**. However, if the present invention is not part of an asset tracking system **100**, the position finder may not be needed. A position finder may be a LORAN **230** or local positioning system. These systems may use signals from local, land-based systems to determine the position of the asset **102**. LORAN systems **230** and their equivalents are well known in the art and will not be explained further. Another position finder **220** may be a system that determines the distance from several cellular towers and can provide a position of the vehicle using the determined distances. This type of system and its equivalents are represented by the cellular tower distance finder **235**.

[0035] In a preferred embodiment, the positional finder **220** would be a GPS receiver **225**. The GPS receiver **225** can receive signals from one or more GPS satellites. A typical GPS receiver **225** decodes and analyzes the pseudo-noise signal from the GPS satellites. The GPS receiver **225** uses the signals to determine a coordinate-based position on the surface of the earth. GPS receivers **225** are well known in the art and will not be explained further. A mobile device **205** can use one or a combination of position finders **220**.

[0036] Another component in the mobile device **205** may be a processor **215**. The processor **215** may be a commercially-purchased microprocessor or microcontroller. As an example, the processor **215** may be from the Intel Pentium™ family, the Motorola PowerPC™ family, or similar type of processor. The processor **215** may also be modeled as a set of logic gates in a specially-designed ASIC or FPGA. For instance, the processor **215** could be modeled in an Altera APEX™ device. Processors **215** are well known in the art and will not be described further

[0037] In some embodiments, a set of sensors **240** can be placed on the asset **102**. The sensors **240** form the sensor array **240**. Hereinafter, the sensors **240** and the sensor array **240** will be explained as interchangeable terms. However, it should be noted that one or more sensors **240** make the sensor array **240**. The sensors **240** can measure different systems or characteristics of the asset **102**. The sensors **240** may be piezoelectric devices, electromechanical devices, or other devices that can provide telemetry.

[0038] In one embodiment, one of the assets **102** may be a vehicle. The sensors **240** can measure parts of the vehicle. For instance, the sensors **240** may measure the pressure in the tires, whether the airbag has been deployed, the amount of fuel in the gas tank, the speed of the vehicle, the current odometer reading, and the achieved miles per gallon. If the vehicle were a

snow plow, the sensors **240** may measure whether a plow is up or down. In a fire truck, the sensor array **240** may measure whether a water pump is operating or not, or the water pressure, or the number of hoses being used. Sensors **240** on a police car may measure whether the sirens are one or off, whether a shotgun has been taken from a gun rack, or whether a person is in custody in the backseat.

[0039] In another embodiment, the asset **102** is a person. With a person, the sensors **240** may measure different biological functions. For instance, the sensors **240** may measure the heartbeat, the blood pressure, the blood sugar level, the respiration rate, or the body temperature. Any biotelemetry capable of being measured can be monitored by the sensor array **240**. Depending on the asset **102**, much other telemetry may be gathered by the sensors **240**. One skilled in the art will recognize other data that may be obtained from the sensors **240**.

[0040] The telemetry can include discrete telemetry, analog telemetry, or digital telemetry. Discrete telemetry is usually a binary function. For instance, a police cars lights are either on or off. Discrete telemetry is normally represented by a single bit with a “1” representing the first state and a “0” representing the second state. Analog telemetry is a digital representation of an analog measurement. For instance, the body temperature of a person may include numerous data points, for instance, 98.7°, 99.2°, or 101.2°. The telemetry would use a plurality of bits to represent what the temperature is at that moment. Finally, digital telemetry is normally a value of some electronic component. For instance, a digital speedometer may be represented by digital telemetry.

[0041] In some embodiments, the mobile device **205** may include one or more of a display device **245**, a man/machine interface **250**, and a memory **255**. The display device **245** may be any type of electronic display. Examples may include CRTs, plasma screens, or LCDs. In one

embodiment, the display device **245** can provide a GIS map. As part of the GIS information, the display device **245** can show streets, vehicles, locations, or other data. In some embodiments, the display device **245** may display satellite imagery or other photographs of locations of interest. The GIS map may be capable of zoom and pan functions. These GIS maps may be in numerous formats including, but not limited to, ESRI shape files. One skilled in the art will recognize other information that the display device **245** may show. Display devices **245** are well known in the art and will not be described further.

[0042] A man/machine interface **250** is any device or system that allows a person to interact with the mobile device **205**. An example of one man/machine interface **250** would be a keyboard. The man/machine interface **250** may also be a touch-screen. As in this embodiment, the display device **245** and man/machine interface **250** may be integrated into a single device. Other embodiments may also use a microphone and speaker. A voice recognition system may employ the microphone to allow interaction between the user and the mobile device **205**. One skilled in the art will recognize other devices that can function as the man/machine interface **250**. Such man/machine interfaces **250** are well known in the art and will not be explained further.

[0043] Another component may be a memory **255**. The memory **255** may provide a place to store the operating system executed by the processor. However, the processor may have internal memory **255** to store the operating system. In other embodiments, the memory **255** may store information for use by the asset **102**. This information may include GIS data. For instance, the memory **255** may store a maps and route information. The memory **255** may include, but is not limited to, any optical, electromagnetic, or electrical memory device. These devices may include, but are not limited to, RAM, ROM, hard drives, optical discs, tapes, or discs. Memory devices **255** are well known in the art and will not be explained further.

[0044] In one embodiment, the processor, the display device **245**, the man/machine interface **250**, and the memory **255** are all included in a computer **260**. This computer **260** may be a laptop computer. The computer **260** can perform all the functions of the other devices. In a further embodiment, the computer **260** incorporates all the components of the mobile device **205**. Essentially, the computer **260** becomes the mobile device **205**. Computers **260** are well known in the art and will not be explained further.

#### Asset server

[0045] As explained earlier, the asset tracking system **100** will usually also include an asset server **116**. Some systems may not include the asset server **116**. Rather, the customers **122** receiver the information from the mobile devices **205** directly over the internet **114**. The asset server **116** can function as the central device that processes and communicates with the mobile devices **205** and the customers **122**. Many embodiments of the asset server **116** exist. One embodiment is shown in **FIG. 3**. The asset server **116** may include one or more parsers **330** and a message switch **335**. Other components may also include, but are not limited to, an internet router **325** and a database **340**.

[0046] The embodiment shown in **FIG. 3** can be used with a wireless network **104**. As explained earlier other communication connections may be made to the asset server **116**. The asset server **116** includes those embodiments needed to use those other communications connections. More discussion will be given to the alternate embodiments below. In the embodiment shown, the mobile device **205** sends signals to a wireless network **104**. The signals are sent onto the internet by a router **310**. Those signals may then be received at the asset server **116**. Sending signals operates in the reverse order. While **FIG.3** shows one specific embodiment, the invention is not limited to that one embodiment.

**[0047]** One device likely part of the asset server **116** is the message switch **335**. Essentially, a message switch **335** functions as a data router or a data relay. Incoming data can have an association with a certain system. For instance, data from a fire truck asset **102** has an association with the fire department asset tracking system **100**. The message switch **335** assigns an address to the fire truck data according to the association and sends that data to the fire department. The process is similar when data is sent to a mobile asset **102**. The fire department sends a location to which a fire truck must respond. The message switch **335** associates the data with one or more fire trucks and sends the message to those assets **102**. Similar associations are given to other assets **102** and their tracking systems. Using these associations, the message switch **335** can receive data from a multitude of sources and send it to the appropriate recipients. For instance, fire system messages go to fire department assets **102**, police system messages go to police department assets **102**, and public works system messages go to public works assets **102**. A message switch **335** can include any hardware device or software program that can effectively route the messages. An example of a message switch **335** would be the Nortel Networks Alteon Application Switch. Message switches **335** are known in the art and will not be explained further.

**[0048]** In one embodiment, the message switch **335** provides data to customer systems **122** in an application program interface (API). The API allows customers **122** or external software to use the data obtained from the various mobile devices **205**. In other words, the message switch **335** puts the data in a standard format for easy use by other programs. Connections with these outside systems **122** may include any internet **114** or intranet connections. In the embodiment shown, the message switch **335** sends data to the customers **122** via the internet. The message switch **335** sends the message to the internet router **325** that transmits the data to the customer

system **122**. In other embodiments, the connection between the message switch **335** and the customer system **122** may include, but is not limited to, wireless LANs, WANs, or other systems using TCP/IP protocol.

[0049] As described earlier, the message switch **335** may manage multiple assets tracking systems **100**. In essence, the message switch **335** can provide the data routing capability for a plurality of asset tracking systems **100**. Thus, the message switch **335** may concurrently receive, process, and provide data from a police asset tracking system **100**, a fire asset tracking system **100**, a snow plow asset tracking system **100**, and other asset tracking systems **100**. Thus, one message switch **335** supports all possible asset tracking systems **100**.

[0050] Another component in the asset server **116** is a parser **330**. The parser **330** functions as a communications interface between the mobile device **205**, the network **104**, and the message switch **335**. A parser **330** is a communication transceiver. Each parser **330** can connect and communicate to or with a different system or with systems using different protocols. For instance, one parser **330** may communicate with mobile devices **205** using a cellular system. This cellular system may be using a CDPD protocol. Another parser **330** may communicate to mobile devices **205** using GSM cellular systems. Yet another parser **330** may communicate with mobile device **205** using a private radio network **104**. Another parser **330** may communicate through a satellite link using an MPEG protocol. The parsers **330** may use any type of communications system or protocol. There is one parser **330** for each type of system or each type of protocol.

[0051] The parsers **330** can receive all the incoming data in different formats. The parser **330** can translate this data from the specific protocols into a standard format. Thus, the parser **330** is a translation device. The parser **330** can be a hardware device or software for changing data in



one format into another. While the embodiment shown only has one parser **330**, there may be a plurality of parsers **330**. One parser **330** can be created for each communication network **104**. In this way, the asset server **116** may only need one message switch **335** for all the different types of network **104s** that may be used. Thus, adding new mobile devices **205** using new network **104s** only requires the addition of more parsers **330**. Such a system provides maximum flexibility because a user does not need to create a new message switch **335** every time a new system is added.

**[0052]** Data sent to the message switch **335** is in a standard format. In the embodiment shown, the standard format would be TCP/IP. However, one skilled in the art will recognize other protocols that may be used for the standard format. Also the standard format may also describe the arrangement of the data. For instance, the asset identifier may precede the asset telemetry and asset position. One skilled in the art will recognize the different arrangements of the data that are possible. A parser **330** may also rearrange the formats and protocols of out-going messages. Thus, the parser **330** can take data in the standard format and translate it into the protocol and format specific to the mobile device **205**.

**[0053]** The asset server **116** may also include a database **340**. A data base is a storage system for asset tracking data. The database **340** may be any type of storage device including, but not limited to, electromagnetic, magnetic, optical, or electrical. An example would be the StorageTek PowderHorn® 9310 System. Other examples may include RAID systems or a storage disc system like one from the Iomega Zip disc family.

**[0054]** Another component may be an internet router **325**. An internet router **325** may be any transceiver that can send and receive messages over the internet. The internet router **325** can help the message switch **335** send information to third party systems. The internet router **325**

may also receive data from a mobile device **205** and send it to the parser **330**. Internet routers **325** are well known in the art and will not be explained further.

**[0055]** In some embodiments, the asset server **116** may be a single computer or several connected computers. For instance, the asset server **116** may include several servers connected as a network **104**. This type of distributed computing may also use other components such as mainframes or workstations. In one embodiment, all the connected devices transfer data using TCP/IP protocol. Data goes through the message switch **335**. At the message switch **335** the data can be sent to another asset server **116**. In another embodiment, two asset servers **116** concurrently receive the data. One of the asset servers **116** can function as a back-up.

**[0056]** Using IP addresses, the asset tracking system **100** may have several separate systems running in parallel. For instance, the asset server **116** may have a back-up system. The back-up system need not be collocated with the primary asset server **116**. Rather, the back-up system can be located in another building, another city, another state, or another country. Any data going to the primary asset server **116** may be copied and retransmitted to the back-up station. The back-up station may have the same IP address and receive duplicate messages from the transmitting devices. A back-up station may have duplicate systems or a different configuration from the primary asset server **116**. One skilled in the art will recognize that there are other architectures and other connections are possible for the asset tracking system **100**.

**[0057]** In other embodiments, a customer system **122** may be connected to the asset server **116**. The customer systems **122** may include, but are not limited to, workstations, mainframes, or server-based system. In the embodiment shown, the customer system **122** is connected to the asset server **116** by the internet. However, any communication connection may be employed including, but not limited to, LANs, WANS, or wireless LANs. The protocol for this connection

may be TCP/IP. One skilled in the art will recognize other protocols that may be used. Also, as explained earlier the data sent to the customer system 122 may be in an API format. This format ensures data is sent and received in the same arrangement every transmission. Thus, any configuration mismatches between the customer system 122 and the mobile devices 205 are eliminated.

#### Method for Maintaining Open Cellular Communications

[0058] Now turning to **FIG. 4**, it shows one embodiment of a method 400 for maintaining a communication pathway or connection through a wireless network firewall 126.

[0059] In an embodiment, the mobile device 205 sends a first heartbeat 405 to the asset server 116. The processor 215 creates the heartbeat. In other embodiments, the wireless transceiver 210 creates the heartbeat. Regardless, the heartbeat may take many forms and be created by various systems.

[0060] One embodiment of the heartbeat 500 is shown in **FIG. 5**. The heartbeat 500 may be analog, but the preferred embodiment uses a digital signal. The digital heartbeat 500 may have any arrangement or number of bits. In **FIG. 5**, the heartbeat 500 has several fields. Those fields may include, but are not limited to, the name of the client 515 (what asset tracking system 100 the mobile device 205 belongs to), the name of the mobile device 515, the data field 520, and the IP protocol header 510 and tail 525. In most embodiments, the IP header 510 and tail 525 are added to the heartbeat 500 by the wireless network 104. All of the fields may have varying lengths. Some fields may be a bit in length while others are thousands of bits or bytes. The lengths of many of the fields can be determined by the protocol used in the asset tracking system 100. Also, the fields may have varying lengths from one signal to the next.

[0061] The IP header **510** can include the dynamic IP address of the mobile device **205**. The name of the device **515** may provide the asset tracking system **100** the data to identify the mobile device **205** in the system. In the embodiment shown, the data field **520** only has a single item in the field. The “H” **530** represents an ASCII “H.” The “H” **530** is the actual heartbeat **500** indicator. While other types of data may be used for the heartbeat **500**, the ASCII “H” provides a simple piece of data to recognize the signal. The IP tail can provide other data for use in the wireless network **104**. One skilled in the art will recognize other possible embodiments of the heartbeat **500**.

[0062] A wireless network **104** receives the heartbeat **500**. In an exemplary embodiment, a cellular tower receives **410** the cellular transmission from the wireless transceiver **210**. The cellular tower relays the signal to the cellular system’s phone exchange or central office. At this point, the heartbeat **500** can be placed on the internet **114**.

[0063] The heartbeat **500** reaches a firewall **126**. The firewall **126** can recognize that the heartbeat **500** is an out-going signal. Thus, the firewall **126** opens **415** a hole **305** in the firewall **126**. The firewall **126** assigns a port for the heartbeat **500** to be sent out. The firewall **126** can assign a time-out clock to this port. In other words, the firewall **126** will leave the port open for any further communication for a set period of time. The set period of time may vary greatly. In some wireless networks **104**, the set period of time may be fractions of a second, while in other networks **104** the set period of time may be 30 seconds or longer. Thus, the firewall **126** waits **420** for a reply or further communication for the set period of time.

[0064] While the firewall **126** waits for a reply, it may check **425** to determine if a response has been made. In another embodiment, the cellular system may receive a notice if a reply is received. If no response has been received **435**, the firewall **126** checks to determine if the time-

out has expired 440. In essence, the firewall 126 determines if the set period of time has elapsed. If the elapsed period of time has not elapsed, the firewall 126 can continue to wait 445.

[0065] Meanwhile, the heartbeat 500 can travel the internet to the internet router 325. The parser 330 can receive the heartbeat 500 from the internet router 325 and format the heartbeat 500 into the standard format. At this point, the parser 330 can relay the heartbeat 500 to the message switch 335. In this way, the mobile device 205 and the message switch 335 have formed a communication pathway. Anytime before the set period of time expires, the message switch 335 may push data to the mobile device 205 without the firewall 126 blocking the transmission.

[0066] The message switch 335 can record the dynamic IP address from the IP Header 510 of the heartbeat 500 and be able to assign that IP address to any reply messages. The dynamic IP address will remain accurate until the set period of time expires. In that situation, the mobile device 205 may need to send another heartbeat 500 to reestablish a connection, and this new heartbeat 500 will include a new IP address. The new heartbeat 500 may be sent on a regular period. For instance, if the time-out occurs every 30 seconds, the mobile device 205 may send the heartbeat 500 on a period of every 20 seconds. In other embodiments, the heartbeat 500 may be sporadic. Essentially, the heartbeat 500 is not sent on an established period, but the heartbeat 500 is sent out at random intervals that do not exceed the time-out of the hole 305 in the firewall 126. A sporadic heartbeat 500 may have a pattern that has a second heartbeat 500 follow the first heartbeat 500 by 22 seconds, a third heartbeat 500 follow the second heartbeat 500 by 12.6 seconds, and so on. In other embodiments, the heartbeat 500 may be triggered by an event. For instance, every time the communications pathway usage falls below 50%, the heartbeat 500 may be sent. The heartbeat 500 may also be sent if no message has been sent for a set number of

seconds that is less than the time-out. For example, if a communication has not been sent for 15 seconds, then a heartbeat **500** would be sent. One skilled in the art will recognize other events that could trigger the heartbeat **500**. One skilled in the art will also recognize other sequences, intervals, or methods for sending out the successive heartbeats **500**.

[0067] Beyond these effects of receiving the heartbeat **500**, the heartbeat **500** functions as a state of the system message. An asset tracking system **100** often requires a process to determine whether the system is functioning properly. One process that is known in the art is polling. Polling requires a central device to send a poll to each connected device and receive a reply from that device. As the number of devices on the system increases, the number of polls increases. When the number of connected devices becomes prolific, polling becomes difficult to manage. A list is usually created and the central device scrolls through the list polling the devices one at a time and awaiting the reply. Unfortunately, this process requires a great deal of processor usage and is overly cumbersome. Thus, heartbeats **500** can provide a simple and less cumbersome method to check functionality.

[0068] Heartbeats **500** eliminate the need to poll connected devices. In this embodiment, each connected mobile device **205** sends a signal to the message switch **335**. The signals are periodic. For instance, a mobile device **205** may send the signal every 30 seconds. Regardless, the signal identifies the mobile device **205** sending the heartbeat **500** to ensure the asset server **116** can determine what mobile devices **205** are on the system and which are functioning. The name of the device **515** or name of the client **515** may function as the identifier in a heartbeat **500**.

[0069] Now that a communication pathway has been formed between the mobile device **205** and the asset server **116**, there may be several methods to maintain this pathway. First, either the mobile device **205** or the asset server **116** can send other communications. The firewall **126** can

understand these other communications as a reply **425** from the asset server **116** or a continuation of the transmission from the mobile device **205**. The types and content of these other communications will be explained further below.

**[0070]** The mobile device **205** may send information including, but not limited to, text messages or asset tracking information. This asset tracking information may include, but is not limited to, the asset's position, asset telemetry, or other information. This information can update the asset server **116** or the customer systems **122**. Each asset **102** can periodically send this information. Thus, the asset tracking system **100** can stay current on position or status of the asset **102**.

**[0071]** The asset position can be one of the items of information sent by the mobile device **205**. In one embodiment, the GPS **225** determines the coordinate position of the asset **102** at a moment in time. Those coordinates are sent to the processor **215**. The processor **215** can save in memory **255** and display on the display device **245** the position. In this way, the asset **102** knows the position. The processor **215** also creates the message that the wireless transceiver **210** will send. After composing the message, the processor **215** forwards the message to the wireless transceiver **210** for transmission.

**[0072]** The transmission enters the wireless network **104** where it reaches the firewall **126**. Since a hole **305** has already been created in the firewall **126**, the firewall **126** sends the message through the same port assigned to the past heartbeat **500**. However, even if the hole **305** were closed in the firewall **126**, the firewall **126** may still allow the transmission since it is an outgoing message.

**[0073]** The message travels through the internet **114** where it is received at the internet router **325**. The parser **330** translates the message and relays it to the message switch **335**. At this

point, the message switch **335** determines the client the message belongs to and forwards the message to one or more of the customers **122**. The asset telemetry is sent to the asset server **116** in like fashion. However, the sensor array **240** provides the information. In this embodiment, the sensor array **240** measures a part of the asset **102**, for example, the tire pressure. That information is put into a message and sent to the asset server **116**.

[0074] In addition, the asset server **116** may send information to the mobile devices **205**. Information sent to the mobile device **205** takes the reverse path of the information received. In an exemplary embodiment, the customer **122** or message switch **335** originates the message. At the message switch **335**, the information is placed in a format for the parser **330**. The parser **330** receives the information and further formats the information for transmission on the specific communications medium. The parser **330** then transmits the message. In one embodiment, the message is sent to the internet router **325** that transmits the information over the internet **114**. The information eventually reaches the router **310**. At this time, the wireless network **104** must determine if this information is an unwanted message. Thus, the firewall **126** reviews the message to determine **430** if it is a reply to a sent message. If the message was received within the first set period of time, then the message will be considered a reply. The message will pass through the hole **305** in the firewall **126**. At the cellular tower, the information is transmitted to the mobile device **205** where the processor **215** can store it or display it. In a situation such as this embodiment, the firewall **126** may renew the set period of time. In essence, the firewall **126** resets the time-out and grants a second set period of time for added communications. The second period of time may be longer or shorter than the first set period of time. In this way, the successive communications can keep the hole **305** open in the firewall **126** without additional heartbeats **500**.



**[0075]** There are many types of information that may be sent to the mobile device **205**. Some of this information may include, but is not limited to, a position to which the asset **102** should proceed, real-time information, information about other mobile devices **205**, a map, a set of directions, a text message, or a heartbeat **500**. Some of this information may also be stored at the mobile device **205**. For instance, the computer **205** can store maps, GIS information, routing information, and other items. In the embodiments that follow, the information will be explained as being sent to the mobile device **205**. One skilled in the art will recognize what information may be stored at the mobile device **205**.

**[0076]** The first type of information that may be sent to the mobile device **205** is information about other assets **102** in the asset tracking system **100**. In this embodiment, one asset **102** may transmit status, position, or other information to the message switch **335**. The message switch **335** can then echo or relay this information to the other mobile devices **205**. Again, the name of the client or name of the device allows the message switch **335** to know what mobile devices **205** should receive that information. In this way, every mobile device **205** in the asset tracking system **100** can display and store GIS and other information about all other mobile devices **205**. This type of system allows command and control of an asset tracking system **100** from the field. Managers and directors can actually see and direct assets **102** from the field. An example of this application may be a forest fire fighters unit. The fire team leader can use their own mobile device **205** to see their crew. That team leader can direct or instruct those personnel according to the information they see on their display device **245**. Other information to send and other applications will be recognized by one skilled in the art.

**[0077]** Another source of information may be real-time information. The real-time data should have some temporal relationship to the moment the data is sent. Real-time information can be

any data or information obtained at that moment or within the recent past. Data that is a day old may still be real-time if no update of that information is available. Also, the data may be real-time if it is retrieved recently, but its creation was in the past. The real-time information may be about a status of a location. For instance, a police department may send a police car to an address. This position is a location of a house. The real-time information may pertain to past police visits to that house. Some examples of this real-time information may include, but are not limited to, blueprints of a building, number of occupants of a building, items stored at a building, descriptions of the occupants, a history of the location, or a history of the occupants. A description of the occupants may include, as an example, be a height, a weight, a color of eyes, a color of their hair, or other characteristics. The history of the occupant may include, but is not limited to, past arrests, past criminal convictions, medical information, employment history, or other information. Items stored at a building may include what inventory is in a warehouse or other data. An example of this type of information would be an inventory of flammable chemicals in a warehouse given to firefighters for their edification. A history of a location may include past police visits, any condemnations of the property, past fires at the location, or other information.

**[0078]** The real-time information may also include information about how to get to the location. This information may include, but is not limited to, a traffic condition, a light signal status, a traffic accident report, a best route to the location, or a parking condition. Some of the information can describe current traffic conditions. For instance, the information may describe where traffic jams are occurring and how to circumvent those areas of heavy traffic. This information may come from sensors placed along, under, or above the roads. A simple pressure sensitive monitor can count the passage of cars and forward this information to the message

switch **335**. Similar monitors can forward the status of the traffic lights to the message switch **335**. A police car may report a traffic accident and provide information about what roads to avoid in the future. All of this information may be interpreted into a best route. The best route would describe a set of directions to the location. These directions can allow the asset **102** to navigate the roads without encountering heavy traffic, traffic accidents, or red lights. Also, the information may include parking conditions. For instance, a service vehicle may need a place to park in the downtown area of a city. The real-time information can include information from parking meters or parking lots showing vacancies. Thus, the asset **102** can find a parking space quickly without searching.

[0079] Another source of real-time information may include location imagery. Imagery may be any form of visual data in any spectral wavelength. Examples of this imagery may include, but are not limited to, satellite imagery, aircraft imagery, remote camera imagery, or imagery from a mobile device **205**. Satellite and aircraft imagery are visual information obtained from sensors on satellites or aircraft. A remote camera may be a permanently placed imager or other device that can transmit the information back to the message switch **335**. The remote camera may also be a part of a mobile system like a train car, a watercraft, or other form of transportation. In addition, the imagery may come from an asset **102** in the asset tracking system **100**. Thus, the imagery can function as a feedback from an asset **102** sent to scout, assay, or reconnoiter a situation. For example, a fire fighter might be sent to take digital pictures of a forest fire and transmit the digital images to the asset tracking system **100**.

[0080] This imagery may be from a dedicated satellite that is part of the asset tracking system **100**. Also, the imagery may come from some service or agency. For instance, the asset tracking system **100** may download information from a government system via an internet delivery

service such as available from the NOAA DMSP, POES, or GOES systems. These satellites may provide one or more images in the different spectral bands. Also, the imagery may come from a private company, such as images from Space Imaging, Inc. The images may even come from an educational institution like the Space Science and Engineering Center at the University of Wisconsin at Madison. One skilled in the art will recognize other available sources of information that may provide imagery. Also, one skilled in the art will recognize the different delivery methods for the imagery. These delivery methods may include, but are not limited to, internet download, email delivery, dedicated link transfer, or mail.

**[0081]** The imagery may be from any spectrum. Thus, the imagery may include, but is not limited to, information from the infrared, visual, sonic, ultraviolet, microwave spectrum. For example, imagery of a forest fire may include visual pictures of the fire, infrared information about fire hotspots, and microwave imagery about moisture conditions. One skilled in the art will recognize other spectrums and products that may be included as imagery.

**[0082]** To enter the imagery into the system, a separate processor or a customer **122** may input the imagery into the system. This imagery may include a set of positioning information, such as GPS **225** coordinates for points on the image. In other embodiments, landmarks in the image may need to be pinpointed and the location information for those landmarks input. Locating landmarks may be done by using a visual display that allows a user to electronically mark a landmark, like a lake, mountain, building, or structure. The user can then use a database **340** to input GPS **225** coordinates for the landmark. With the positioning information, the asset tracking system **100** may place this image in the asset tracking system **100** as a background display. One skilled in the art will recognize other methods of entering the image information

into the asset tracking system **100**. One skilled in the art will recognize other types of real-time information that may be sent to the mobile device **205**.

**[0083]** In another embodiment of the invention, the message switch **335** or the mobile device **205** may send text messages as a form of information. Text messages are communications using text to convey a message to the recipient. For instance, a text message may communicate information to the asset **102** that cannot be displayed or conveyed in another form. These text messages may originate with or be addressed to the mobile device **102**, the customer **122**, the asset server **116**, or some other system. An example of a text message may be the dispatch center telling the police officer, using the asset **102**, that his or her child is in the hospital and he or she should leave work immediately. There are numerous other examples of text messages, and one skilled in the art will recognize those different possible text messages. Text messages have been used in internet communications. Text messages are well known in the art and will not be explained further. However, it should be noted that the present invention may facilitate text messaging in other networks not just in asset tracking systems **100**. For instance, the present invention may maintain communication pathways for a mobile computer (the mobile device **205**) to use text messaging over a wireless network (the communication network **104**). One skilled in the art will recognize the different networks and applications for the present invention to facilitate text messaging.

**[0084]** A situation may occur where no information is sent **435** between the mobile device **205** and the message switch **335** for a long period of time. The wireless network **104** can also determine **440** if this absence of communication runs longer than the set period of time that the hole **305** remains open. If the time-out for the hole **305** has not elapsed **445**, the wireless network **104** may continue to wait for a communication **420**. If the time is about to elapse **450**,

another heartbeat **500** may be sent **405** between the mobile device **205** and the asset server **116**. Heartbeats **500** from the asset server **116** to the mobile device **205** may also be sent **405**. These heartbeats **500** can allow the mobile device **205** to determine if the mobile device **205** is still connected to the asset tracking system **100**. If the scheduled heartbeat **500** is not received and the time has elapsed **445**, the mobile device **205** can reconnect by reestablishing (not shown) a wireless connection. These heartbeats **500** also can inform the mobile device **205** if the asset tracking system **100** is functioning. For instance, if the asset server **116** is down, the mobile device **205** will not receive heartbeats **500**. The mobile device **205** may then inform the user of the mobile device **205** that alternate communications may be necessary.

[0085] Either the asset server **116** or the mobile device **205** may send a successive heartbeat **500**. Thus, either device may know when the set period of time expires for keeping the hole **305** open. Before that time expires, either device may send a new heartbeat **500**. This new heartbeat **500** can reset the set period of time or can establish a new set period of time. The successive heartbeats **500** can maintain the hole **305** through the firewall **126** without any communications between the mobile device **205** and the asset server **116**. In this way, the heartbeats **500** maintain the communications pathway indefinitely. The connection can allow the asset server **116** to push data whenever required without the mobile device **205** establishing a new connection.

[0086] In some embodiments, a new heartbeat **500** may not be sent. The asset tracking system **100** may desire to terminate the connection **460** between a mobile device **205** and the asset server **116**. For instance, if a service vehicle will not be used overnight, the heartbeats **500** may stop and the connection terminated. One skilled in the art will recognize other situations where the connection may be terminated. The wireless network **104** can simply close the hole **305** in the firewall **126**. If no heartbeats **500** or other communications are transmitted between the mobile

device **205** and the asset server **116**, the set period of time lapses and the wireless network **104** can close the hole **305**. Thus, unused assets **102** may not remain on the system **100** and require data pushed to that mobile device **205**. In other embodiments, either the mobile device **205** or the asset server **116** may instruct the connection to be terminated. One skilled in the art will recognize other methods for terminating the connection.